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Forest Service **RESEARCH NOTE**

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NATURAL FILTERING OF SUSPENDED SOIL BY A STREAM AT LOW FLOW

by

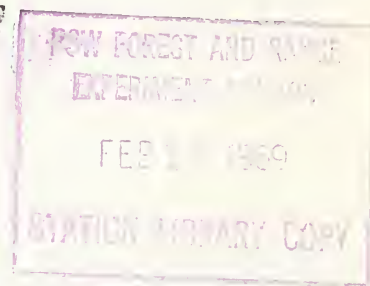
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Abstract

During road construction, soil that is added to a stream by tractors crossing during low flow is temporarily "filtered" out before it travels far. Five-gallon samples were taken at 150, 300, 600, and 1,200 feet downstream from a road crossing, with sodium fluorescein dye used as a tracer. Suspended particle concentration was reduced from 1,055 p.p.m. at 150 feet below the road to 108 p.p.m. at 1,200 feet. The "filtering" action is a combination of settling of larger particles and dilution of sediment-laden water. This filtration is temporary and deposited soil will tend to be flushed downstream during high flows and may cause channel erosion or other damage.

Introduction

During forest road construction, quantities of soil may be introduced into streams by tractors crossing the stream before culverts or bridges are installed. On Bull Run Experimental Watersheds in the Cascade Range of northwest Oregon, a significant quantity of soil was put into the stream by tractors but was not observed at the streamflow measuring station one-half mile below the road construction. To trace the soil movement, we measured the suspended solids, added by a single tractor crossing, at intervals to 1,200 feet downstream. The stream had a low-gradient, rocky channel with many pools, and flow was less than one-half cubic foot per second--a low-streamflow situation in August 1964.



Methods

Sediment-laden water was followed visually until it reached the first sampling point 150 feet downstream from the road crossing. There, a 5-gallon sample was taken by successively filling a pint sample bottle at a small overfall. At this time, sodium fluorescein solution (a brilliant yellow-green dye) was added to the stream to identify the same general water mass at sampling points further downstream.^{1/} Additional 5-gallon samples were taken when the dye reached sampling points located 300, 600, and 1,200 feet downstream from the road construction. The actual flow distance of the water meandering around the rocks was 1-1/2 to 2 times greater than the length of channel. Three hours elapsed while water flowed from the road crossing to the last sampling point.

Samples were taken to the laboratory and sieved through a 0.05-millimeter (300-mesh) screen to separate the sand-size particles. One-liter subsamples of the sieved solution were used for determining the silt and clay fraction by the pipette method.^{2/}

Results

The particle-size analysis data plotted in figure 1 show a tenfold reduction in total suspended-solids concentration during flow through 1,050 feet of stream channel. As expected, sand dropped out quickly; its concentration fell from 80 to 2-1/2 parts per million (p.p.m.) in the first 150 feet. The silt concentration steadily declined from 600 to 3 p.p.m. over the whole 1,050-foot distance. The apparent initial increase in clay concentration between 150 and 300 feet is attributed to sampling error. Clay concentration decreased from about 400 to 100 p.p.m. at the last station.

Several reasons exist for the marked reduction in suspended solids with increasing distance from point of input. Gravitational force continuously causes particle deposition. Deposition increases when flow slows in pools and side eddies. Mosses growing on submerged rocks reduce flow velocity and encourage deposition. Moss also presents a large surface area to collect particles.

A third explanation for the decrease in concentration is the dilution effect of water in pools. At every pool some mixing of dirty

^{1/} Wright, Robert R., and Collings, Michael R. Application of fluorescent tracing techniques to hydrologic studies. J. Amer. Water Works Ass. 56(6): 748-754. 1964.

^{2/} Kilmer, Victor J., and Alexander, Lyle T. Methods of making mechanical analyses of soils. Soil Sci. 68: 15-24. 1949.

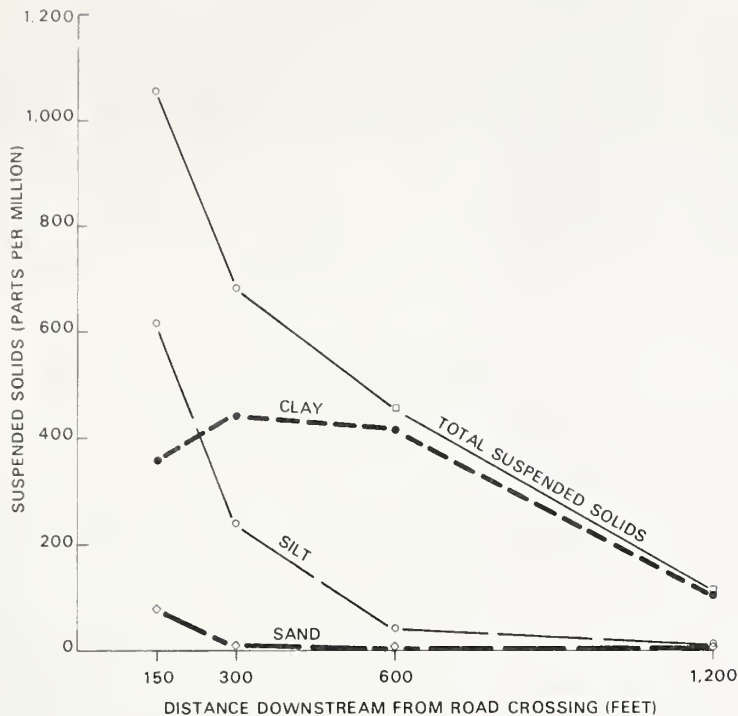


Figure 1.--Suspended-solids concentration at several distances from study road crossing. Bull Run Experimental Watershed No. 1.

and clear water occurs, and water leaves the pool with a lower suspended solids concentration than when it entered. Dilution increases the volume of turbid water and extends the length of the affected water mass as it moves downstream.

Discussion

Suspended particles lower water quality, and efforts should be made to keep tractors out of streams above a campground or water supply inlet. However, during low-flow conditions the natural "filtering" action of the stream tends to reduce particle concentrations within a relatively short distance, and careful operations may be carried out without seriously impairing the water supply. If particles are introduced into higher, more turbulent flows, particles will move further downstream before being deposited, but concentrations may still be reduced because the diluting volume is greater.

Undisturbed stream channels in natural forest are relatively stable. Soil added from any source disturbs this stability and will be flushed from the channel by subsequent high flows. Flushing of deposits may cause accelerated bank or channel cutting. The relatively rapid clearing of water below a work area may lead to an underestimate of the potential damage from introduced soil. Even intermittent additions of soil to the stream or occasional stream channel disturbances should be regarded as harmful. Thus, every effort should be made during road construction to install culverts without disturbing the channel and to install culverts or bridges as early as possible to provide dry crossings for mechanical equipment.

Acknowledgments

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